Applicability of the Studio Pedagogy for the Preparation of a Future Workforce

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Purpose: The primary objective is to identify key takeaways after implementing the LAB Studio Model or LSM pedagogy. Rather than focusing mainly on what the students learned, the study focuses on how they learned based on their experiences in the LSM pedagogy. This model was implemented at Oulu University of Applied Sciences in Finland during 2014-18. It was part of an experiment to help prepare the students for workplace learning in the era of Industry 4.0.

Study design/methodology/approach: The study applies the explorative case-study research methodology. The interview was conducted with the two instructors responsible for planning and implementing the LSM pedagogy. After gathering opinions and thoughts from these two instructors, the next step was to conclude in conjunction with contemporary learning frameworks and practices.

Findings: The study identified 12 key takeaways that contribute positively to learning and motivation to learn. These key takeaways are important for future research into how the students learned during the LSM pedagogy.

Originality/value: The key takeaways are consistent with the previous findings in current pedagogical practices, potentially contributing to learning. Learning how to learn is an integral part of future work in the era of Industry 4.0

Keywords: Learning, Industry 4.0, LAB Studio Model, motivation.

Introduction

Transitioning into Industry 4.0 (Rojko, 2017; Pereira & Romero, 2017) requires drastic adjustments in many areas (Gomes et al., 2015; Anselmann, 2022). Industry 4.0 extends the foundation of Industry 3.0, where computerisation was introduced and adopted. Due to the rapidly- changing business environment, from the context of workplace learning, Industry 4.0 indicates the integration of learning into work (Kluger and DeNisi, 1996;). This integration is important to ensure workplace adaptation, agility, and responsiveness. In today's workplace environment, the emphasis is on learning as knowledge to perform work can be easily obsolete, while training is viewed as reactive.

From product and customer strategies to digitalising work processes, many companies must fully embrace the development of their workforce or human capital (World Economic Forum, 2018). Instead of training, a company in the era of Industry 4.0 needs to focus on learning as the term knowledge worker is being referred to now as learning worker (Masood & Pareto, 2021). The workers are expected to perform the required tasks while continuously learning about work (Kluger & DeNisi, 1996; Masood & Pareto, 2021).

Due to a decline in the workforce, the ability to learn is recognised as an important competitive advantage (Argyris, 1991; Johnson et al., 2018). Given many past business uncertainties, how an organisation can adapt depends largely on effective workplace learning. Since the early 1900s, the prevailing paradigm has been finding the 'best' way and ensuring the right

woman/man for the right job. This paradigm has contributed to constant training. Hence, underperforming workers are replaceable.

A decline in the qualified workforce, as well as a viewpoint that training is reactionary, underlines the shift in the perception of workplace learning (Anselmann, 2022). This shift is further supported by the so-called new waste (or the eighth waste) (Clardy, 2018). It is known as the unused or underutilisation of workforce talents- as the most essential talent is the ability to learn. Note that the knowledge from training and education can be easily obsolete (Tynjala, 2008; Rohrer & Harold, 2010). See Figure 1.

Figure 1: Unused Talent-Ability to Learn from the Workforce. Source: https://theleanway.net/The-8-Wastes-of-Lean.

Workplace learning focuses on how an individual learns and how he or she is motivated to learn. The challenge is that the nature of the research on learning is viewed as multidisciplinary-engineering (e.g., design and construction of feedback), engagement (e.g., emotional intelligence), motivation (e.g., psychological safety) (Vollmeyer & Rheinberg, 2005; Keller, 2010). Interestingly, a typical workplace has three worker types- engaged, non-engaged, and disengaged. To examine many critical issues in workplace learning, many studies have adapted classroom learning as a surrogate (Violato et al., 2008). Similarly, a classroom traditionally views the students in three groups- active, passive, and blocked learners. These three classifications in a classroom correspond to those of a workplace. This notion further supports using a classroom as a surrogate for a workplace from the learning viewpoint.

Literature review

There is general agreement that a rapidly changing business environment will profoundly affect education and students' learning (e.g., Toffler, 1990; Drucker, 1993; OECD, 2005). These effects point to a need for lifelong learning among university graduates. Performing the work through knowledge was an important part of the knowledge economy. At the same time, an emerging belief indicated that a worker would also acquire new knowledge through experiences, peers' interactions, and feedback to deal with a wicked operating environment on a timely basis (OECD, 2005; Kilpi, 2016; Bughin et al., 2018).

Thus, a workplace needs to develop T-shaped skills for a worker. A T-shaped worker is viewed as an adaptive innovator who appreciates the need to work across various disciplines to complete required tasks. A T-shaped worker is not only a person who creates new products/ services but also solves a complex problem that can affect industrial and business operations

(Reiter-Palmon et al., 2012; Demirkan & Spohrer, 2018). To support this shift in the workforce, higher education institutes need to prepare future workers who can concurrently work and learn. As a result, an individual should have an opportunity to learn formally and informally (ILO, 2008). Thus, a classroom should be designed to reflect a workplace.

Given the challenge for a firm operating in the era of Industry 4.0 and the need for university graduates to be prepared for a new way of work (i.e., simultaneous working and learning), many improvement interventions in a classroom are needed. Thus, studio pedagogy is a learning approach that stresses hands-on experiences, experiential learning, informal learning, interaction, and engagement in a studio setting open space (Kuhn, 2001). Critical thinking, problem solving, peer or community of learning, and constant feedback are common descriptions of studio pedagogy. This pedagogy highlights the importance of a learning process - how an individual learns versus what an individual learns (Schön, 1987).

Oulu University of Applied Sciences (Oamk) Oamk LAB's educational program serves as a business pre-incubator designed to educate and foster the development of self-aware professionals and self-directed teams. The Oamk LABs educational program utilises a specific model known as the LAB Studio Model (LSM), which represents studio-based learning for developing students' T-shaped skills (Heikkinen & Stevenson, 2016; Seppänen et al., 2016). The LSM represents a versatile educational approach that I) fosters the development of proficient professionals, II) self-directed teams, and III) entrepreneurial ventures, all IV) is centered around a specific industry focus (Heikkinen & Stevenson, 2016). The LSM approach allows continuous feedback (not assessment and evaluation).

The LSM also provides an opportunity and feedback to ensure that a learner knows the importance of multidisciplinary knowledge while being prepared to develop in-depth technical skills, as outlined by the T-shaped model. The LSM is typically based on personalised workspace (i.e., a dedicated and flexible learning space like in a private firm for brainstorming and discussion as well as coaching, a lecture room in a theatre setting, a meeting room, that can be conveniently reserved by students for a meeting with business operators and other external stakeholders, and a kitchen area which allows free access for refreshments or meals. (Heikkinen and Stevenson 2016). See Figure 2.

Figure 2: Illustration of Flexible Learning Space during Coaching.

Objective statement

The primary objective is to identify key takeaways after implementing the LSM pedagogy within the learning context. Rather than focusing mainly on what the students learned, the study focuses on how they learned based on their experiences in the LSM pedagogy. The LSM pedagogy was applied at Oamk during 2014-18 as part of an attempt to introduce a new pedagogical practice to help encourage and promote learning (i.e., how the students learned). This pedagogy was part of an experiment to help prepare the students for workplace learning in the era of Industry 4.0. It is deemed by Oamk staff that, after the gap of 5 years, it is important to evaluate the effectiveness of the LSM pedagogy. This gap should be sufficient for former students to notice and appreciate their learning experiences and the impacts on professional development within their workplace today. It is important to note that the key takeaways from the LSM pedagogy need to be first identified. This identification is important for the next step of the study, which will involve the development of a survey (based on these key takeaways). This next phase will extend the survey to more than 600 students participating in the LSM during 2014-18. Thus, the scope of the current study is primarily about identifying and confirming the key takeaways. On the other hand, the survey and the attempt to reach out to the former students are outside the scope of this first phase.

Study's Method

The study applies the explorative case-study research methodology. This type of research is particularly valuable when a general idea or a specific question is wished to be investigated. Nevertheless, more pre-existing knowledge or established paradigms must be needed to guide one's study (Eisenhardt, 1989; Heale, 2018). As mentioned earlier, the study focuses primarily on identifying key takeaways from the perspective of instructional staff who are involved actively with the LSM pedagogy[1]. The next step of this study is to gather what through a session with the two instructors involved with the design, development, and monitoring of the progress of the LSM pedagogy.[2]. It is important that, in this step, in-depth examination and discussion with a few instructors are made based on their impression and expectations relating to learning and motivation.[3] (Karjalainen et al., 2016).

The discussion with the instructor is semi-structured with the following focus areas- the frequency and type of feedback provided, group interactions, perceived improvement in learning skills, knowledge acquisition, ability to meet deadlines and requirements, and other factors related to student engagement, trust, and autonomy. To ensure a comprehensive understanding of the subject matter by the learners, an interview was conducted with the selected two instructors. These instructors closely observed the students' daily and weekly activities, mainly coaching and guidance, in-class and in-group discussions, and conversations with business operators. They were primarily responsible for the design, development, and use of the LSM pedagogy. This is why they were chosen to provide their thoughts and opinions on expectations and impressions of the LSM pedagogy.

After gathering opinions and thoughts from the two instructors, the next step is to conclude this reflection. This step is to be conducted with contemporary learning frameworks and practices

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[1] Altogether, there are over 600 students who participated in the Oamk LAB's LSM learning setting, along with 35 faculty staff and a dozen partners from the private sector from 2014-2018.

[2] These two instructors are also the co-authors of this article.

[3] It is important to note that this study represents the first stage of assessing and evaluating the LSM pedagogy. This first part is on identifying the impression and expectation of the instructors. Afterwards, a survey (for the second stage) will be developed to determine how learning occurred. Note that this second stage is not part of the article.

such as informal learning (e.g., intent to learn attitude, feedback as part of group's conversations, time for reflection, perceived safe learning environment, etc.), trust (e.g., willingness to collaborate and share ideas, active listening, member interactions, etc.), and psychological safety (e.g., perceived sense of belongingness, open discussion, willingness to raise concerns and questions, etc.). In addition, this step will consider the Double-loop Learning concept (Argyris, 1991). This concept reminds the two instructors about how feedback was applied in the LSM pedagogy. Also, this step will be conducted in conjunction with a previous report which examined the initial impacts of the LSM pedagogy (Heikkinen, 2018). See Figure 3.
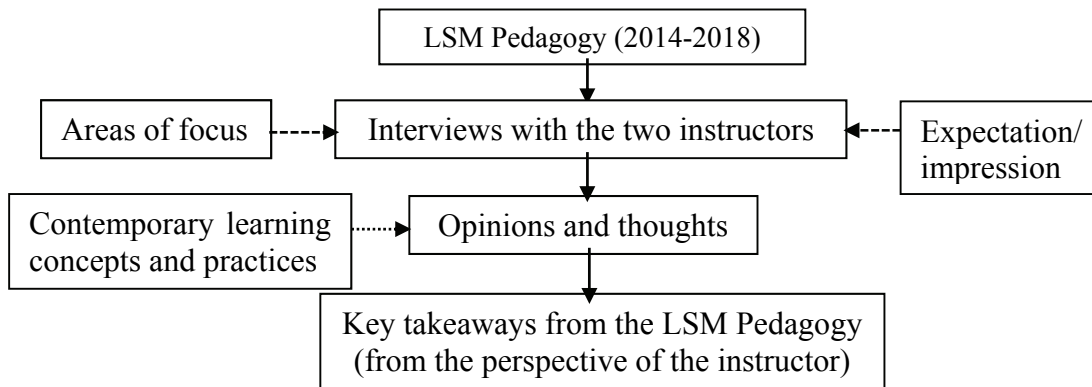
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                        │Key takeaways from the LSM     │
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Figure 3: Study's Method.

Findings

The results from the repeated observations from 2014-2018 (representing the immediate effects) and the informal sessions (reflecting the enduring effects) can be shown as follows. The impacts and the changes that have taken place can be viewed as the characteristics and contributors to the learners' behaviour, attitude, and competence. For each academic year, the learners were aware of the nature of the LSM pedagogy, which emphasised problem-based learning with a team approach. In addition, continuous participation from the companies during project planning and evaluation (e.g., design and development of a product) was explained to the learners. Thus, the learners had good insights into the LSM pedagogy.

For the enduring effects (based on the Double-loop Learning concept), examining constructive feedback, constant communication, active engagement from external entities, coaching, and working that resembles a workplace contribute to a new mindset in many ways. These include the feeling that the learners were performing correctly, the belief that they could achieve their potential with hard work, and the motivation to learn and acquire actual and essential skills for their future. The key takeaways are as follows.

Table 1: Key Takeaways from the Study

Key takeaway	Justification
Key takeaway 1: Trust for the teams and individuals during learning activities.	The value of trust in education stems from the belief that learners can contribute their best efforts to achieve shared team goals. This trust is founded on the understanding that learners' mistakes can be addressed, discussed, and overcome. As a result, trustful and equitable relationships are fostered, extending among team members and involving the staff. Learners are motivated to face challenges, practice, and explore new solutions, embracing failures as part of the learning process. This approach has proven effective in cultivating independent learners, with support from studies by Dweck (2009), Saavedra and Opfer (2012), and Karjalainen et al. (2016).

Key takeaway 2: Increasing numbers of self-directive actions.	Self-directed actions by learners signify a heightened level of motivation, driven by increased confidence resulting from knowledge and awareness essential for both structured and unstructured activities. Personal interests, continuous feedback, and a sense of purpose influence successful self-directed actions during learning. Ongoing collaboration between learners and faculty, including regular formal sessions held at least once a month, further bolsters their confidence. Learners are also aware of the option to arrange special and formal reviews with faculty staff, adding to their sense of empowerment and ownership in their educational journey.
Key takeaway 3: More proactive in decision-making	Previous research (e.g., Yip, 2006; and Dierdoff and Rubin, 2015) highlights that when learners are informed about their work progress and the tasks ahead, they are more empowered to make decisions with their team members. This leads to improved conflict management during project and assignment work. The sense of autonomy encourages learners to address problems independently, without waiting for specific faculty instructions. The coaching style fosters this behaviour by encouraging teachers to ask questions rather than provide immediate answers during student-team decision-making. Consequently, the studio-based environment nurtures the acquisition of valuable work-life skills in a supportive atmosphere that embraces the learning opportunities arising from failure.
Key takeaway 4: Becoming familiar with actual work and workplace.	The LSM pedagogy exposes learners to an open learning space where they can utilise available tools and materials to complete projects and assignments successfully. The approach encourages learners to take advantage of the resources at hand, as supported by Heikkinen and Stevenson (2016). For project work, learners enjoy unrestricted access to the campus and have full control over equipment and aesthetics. The workspace includes multiple rooms of varying sizes, catering to project teams and individuals. Additionally, each project team is granted a budget for prototyping materials and testing activities, which, while not overly generous, covers the essential materials needed for a prototype.
Key takeaway 5: Blending digital tools for collaborative and participatory learning.	The LSM pedagogy significantly emphasises simulating the classroom as an actual workplace. A range of digital tools commonly used in professional settings are provided to achieve this. Notably, digital learning platforms are crucial in facilitating collaborative project work, such as documentation and simple design tasks, and supporting project communication, including team meetings and interactions with external clients through meetings and remote testing. Moreover, these platforms enable seamless communication between students and teachers/coaches, fostering active participation beyond the physical studio environment.
Key takeaway 6: Feedback and coaching as part of informal learning.	The LSM pedagogy fosters a culture of continuous feedback within the learner group, where feedback and evaluation are distinct but interconnected concepts. Formal and informal sessions ensure that individuals and project teams regularly receive feedback, making it an integral part of daily activities in the studio classroom. Providing constructive feedback is vital for learning, empowering learners to plan and determine their goals, encompassing personal/professional development, learning opportunities, and work integration (Boud et al., 1999). Feedback also serves as a form of coaching in the LSM pedagogy, which incorporates three types: role coaching, focusing on specific professional areas like business design to promote learners' growth; project coaching, aimed at enhancing project performance through resourceful guidance via questions, with a lead faculty member acting as a responsible coach for project teams; and team tutoring. This multifaceted approach to coaching nurtures learners' professional development and project success within the supportive studio environment.
Key takeaway 7: Integrating uncertainty into classroom settings.	Future professionals must possess essential skills like tolerance for uncertainty, open-mindedness, a willingness to self-correct, and the ability to reach a consensus. These traits are substantiated by various studies, including the EU Commission's EntreComp framework (European Commission, 2023). Moreover, these skills align with critical thinkers who demonstrate resourcefulness, information gathering, and perseverance

	when faced with challenging situations that lack immediate solutions (Halpern, 2007). Critical thinking is closely tied to civic literacy, relying on evidence-based reasoning. Teaching critical thinking in the LSM pedagogy prioritises the development of reasoning skills, even allowing for the possibility of making mistakes, as an integral part of the learning process. Emphasising the role of faculty members as coaches, the pedagogy focuses on building students' self-esteem and supporting their personal development, nurturing their growth as future professionals equipped with essential skills for success.
Key takeaway 8: Professional development derived from problems at hand.	The LSM pedagogy promotes problem-based learning, where learners are encouraged to openly share and discuss their challenges during project planning and implementation. This approach aligns with the principles of "learning by doing" (Dewey, 1904) and "experiential learning" (Kolb, 2014), providing hands-on experiences that enhance problem-solving skills. One of the key factors contributing to success in this pedagogy is the faculty member's role in facilitating learning among the students. Facilitating goes beyond traditional teaching and involves providing advice, support, and encouragement to learners as they navigate difficult periods and encounter unclear solutions. The faculty member fosters problem sharing and awareness among the learners, empowering them to take ownership of their learning journey and develop a deeper understanding of the subject matter through practical application.
Key takeaway 9: Importance of psychological safety and importance of inclusiveness for learning	The LSM environment fosters an open working space and encourages a free flow of constructive feedback, leading to a prevailing sense of psychological safety. Learners feel comfortable expressing their thoughts and feelings openly, knowing they will not face reprimands from their peers or faculty staff. Inclusiveness plays a vital role in enhancing productivity and efficiency in work and time management among learners, as supported by Sitko-Lutek and Jakubiak (2020). This feeling of togetherness is essential in the classroom and workplace setting, promoting self-reflection and contributing to a deeper learning experience. The supportive and inclusive atmosphere of the LSM environment nurtures personal growth and enables learners to reach their full potential.
Key takeaway 10: Meaningfulness of work in classroom settings.	A crucial aspect of project-based learning in the LSM pedagogy is the emphasis on selecting problems that require interdisciplinary teams. This approach leads to the discovery of novel business opportunities or tackling wicked problems where complexity demands collaboration across different fields. Consequently, one of the most important practices is the ability to screen and remove poor or mediocre projects during the planning phase (Heikkinen & Stevenson, 2016). At the beginning of the learning process, numerous concepts are initiated, but only about half are chosen to proceed after a pitching event called 'Gates'. Following the two-gate structure, approximately one out of four initial projects presented at the beginning are approved for continuation. This rigorous selection process is highly significant, as it exposes learners to real-world experiences and ensures the pursuit of high-quality and impactful projects. The result is a learning environment that prepares learners to thrive in complex, interdisciplinary settings, equipping them with the skills needed to tackle real-world challenges effectively.
Key takeaway 11: Importance of a stable learning environment for knowledge creation	Research conducted within a studio environment highlights the significance of stable learning environments in fostering effective knowledge acquisition and retention. Heikkinen and Räisänen's study in 2018 found that collaborative problem-solving, a prominent feature of the LSM pedagogy, can be highly advantageous for learners. In this context, exposure to real work and ongoing projects, accompanied by ample opportunities for socialisation, is crucial (Nonaka, 1994; Nonaka & Takeuchi, 1995). Socialisation is vital in improving learners' self-confidence and facilitating shared problem-solving and co-creation of knowledge. Engaging in collaborative efforts and

	interactions within the studio environment empowers learners to develop a deeper understanding of the subject matter through active participation and discussions with peers. The LSM pedagogy's emphasis on collaboration and socialisation fosters an enriched learning experience that promotes self-assurance and enhances learners' ability to solve complex challenges and co-generate knowledge collectively.
Key takeaway 12: Impacts of a community of learners on learning.	In the LSM pedagogy, open collaboration among learners, faculty staff, and partners is fundamental to creating a strong community of learners, as emphasised by Brown and Campione (1994). This collaborative approach has resulted in positive impacts on active learning. Throughout the planning and execution of projects and assignments, learning goals and methods are openly iteratively discussed multiple times, forming the bedrock of this community. Gradually building such a community in a trusting environment helps bridge boundaries and minimise personal biases, mainly when learners come from diverse educational backgrounds and experiences (Akkerman & Bakker, 2011). Projects and assignments with customer expectations necessitate collaborative work among learners. The process of developing learning goals collectively becomes a symbolic representation of the community of learners, signifying their shared commitment to growth and mutual success. The LSM pedagogy cultivates an environment where participants can thrive and contribute their unique perspectives to create innovative and impactful solutions by fostering open collaboration and establishing a community of learners.

Discussion

The LSM pedagogy reveals that the unused talents in a workplace can be overcome. There are many key takeaways from the immediate effects based on the repeated observations- including psychological safety, a safe learning environment, open space, constant feedback, informal learning, group interactions, trust, etc. Many developments have occurred over the experiment, such as the ability to set self-learning goals, the willingness to share and transfer knowledge, the openness to discuss problems, maturity when dealing with complex problems, etc. These key takeaways are also confirmed by examining the enduring effects.

The studio type of learning environments and approach findings also show similar takeaways that appear to influence students' motivation (Schnittka et al., 2012; Rodriguez et al., 2018; Bejtic, 2019; and Oguamanam et al., 2020). In addition, by integrating the work-life approach into pedagogical practices, the studio environment offers enriched learning experiences that contribute positively to career preparation. The enrichment of experiences stems largely from integrating psychology into teaching and learning. Within the LSM pedagogy, motivation to learn was viewed as one of the critical foundations for learning and development. This is also consistent with the expectations and impressions of the two instructors who participated in the interview (Heikkinen *et al.*, 2016). It is important to underline further that learning how to learn is an integral part of future work in the era of Industry 4.0.

Autonomy - the degree to which an individual can control their work schedule, tasks, and responsibilities (Ryan & Deci, 2017) - through constant feedback and informal learning is essential to facilitating learning among group members. The autonomy also contributes to the sense of belongingness (through a community of learners) and psychological safety (through a safe learning environment). Trust from open working space through informal learning also strengthens employability skills such as communication, problem-solving, team building (in a group environment), etc. At the same time, emotional maturity (e.g. ability to cope with deadlines, complex problems, client's problems) has also been improved noticeably. Finally, another significant implication is that the motivation to learn depends on the meaningful

relationships among the learners within a project team. This is due to a challenge or a problem that is an integral part of learning when undertaking projects and assignments.

Future Research

Based on the above key takeaways, the next stage of the study will examine their impacts on the learning and development of the learners. This examination will focus on the level of learning interest, the feeling of classroom engagement, the level of learning motivation, the perceived change in learning behaviour, etc. A survey, derived from the key takeaways and the relevant learning theories (mainly, the Double Loop Learning concept and Theory of Planned Behaviour), will be developed to help assess how the students learned during the LSM pedagogy. The expected outcomes from this next stage are the interrelationships among the key takeaways on the learning and development of the students. These outcomes include the responses to the questions about what entices the students' learning interests, what motivates them, and what sustains their learning interests.

Conclusion

This study is based on implementing the LAB Studio Model (LSM) pedagogy within the Oamk LABs educational program at Oulu University of Applied Sciences. The study draws on a wealth of data collected from 2014 to 2018 over five years. Over 600 students participated in over 80 different projects and assignments during this time, providing a rich and diverse range of experiences and perspectives to draw upon. Based on the immediate and enduring effects, 12 important key takeaways influence learning and motivation to learn. Further investigations are needed to help verify and validate these initial findings and their lasting impacts on learning skills, which is essential for a workplace in the era of Industry 4.0.

References

Akkerman, S. F., & Bakker, A. (2011). Boundary crossing and boundary objects. *Review of educational research, 81*(2), 132-169.

Anselmann, S. (2022). Trainers' learning conditions, informal and formal learning and barriers to learning, *Journal of Workplace Learning, 34*(8), 742-764.

Argyris, C. (1991). Teaching smart people how to learn, *Harvard Business Review.* 69(3), 99–109.

Bejtic, Z. (2019). The pedagogy of creative disciplines: Teaching techniques and approaches that increase students' intrinsic motivation in a studio classroom.'. In *Proceeding of International Conference on Advanced Research in Education,* pp. 7–9.

Boud, D., Cohen, R., & Sampson, J. (1999). Peer learning and assessment. *Assessment & evaluation in higher education, 24*(4), 413–426.

Brown, A., & Campione, J. (1994). *Guided discovery in a community of learners.* The MIT Press.

Bughin, J., Hazan, E., Lund, S., Dahlström, P., Wiesinger, A., & Subramaniam, A. (2018). Skill shift: Automation and the future of the workforce. *McKinsey Global Institute,* 1, 3-84.

Clardy, A. (2018). 70-20-10 and the Dominance of informal learning: a fact in search of evidence, *Human Resource Development Review, 17*(2), 153–176.

Demirkan, H., & Spohrer, J. C. (2018). Commentary—cultivating T-shaped professionals in the era of digital transformation. *Service Science, 10*(1), 98-109.

Dewey, J. (1904). The relation of theory to practice in education. *Teachers College Record, 5*(6), 9–30.

Dierdorff, E., & Rubin, R. (2015). We're not very self-aware, especially at work. *Harvard Business Review.* Retrieved from https://hbr.org/2015/03/research-were-not-very-self-aware-especially-at-work.

Drucker, P. (1993). The rise of the knowledge society. *The Wilson Quarterly, 17*(2), 52–72.

Dweck, C. S. (2009). Mindsets: Developing talent through a growth mindset. *Olympic Coach, 21*(1), 4–7.

Eisenhardt, K. (1989). Building theories from case study research. *Academy of Management Review, 14*(4), 532–550.

European Commission (2023). EntreComp: The entrepreneurship competence framework. *EU Science Hub.* Brussels, Belgium. Retrieved from: https://joint-research-centre.ec.europa.eu/entrecomp-entrepreneurship competence-framework_en.

Gomes, C., Kruguanska, S., Gouvea, I., Madruga, L., & Schuch, V. (2015). Conditioning factors for learning-oriented organisations", *International Journal of Innovation and Learning, 17*(4), 453-469.

Halpern, D. (2007). *The Nature and Nurture of Critical Thinking.* Cambridge University Press.

Heale R. (2018). What is a case study? *Evidence-Based Nursing, 21*(1), 7–8.

Heikkinen, K.P. (2018). Exploring studio-based higher education for T-shaped knowledge workers, case LAB studio model. *Doctoral dissertation.* Oulu: University of Oulu.

Heikkinen, K.P., & Räisänen, T. (2018). Role of Multidisciplinary and Interdisciplinary Education in Computer Science: A Literature Review. *Managing Global Transitions, 16*(2), 159-172.

Heikkinen, K.P., Seppänen, U.-M., & Isokangas, J. (2015). LAB studio model: Developing external networks for learning entrepreneurship in higher education, *Education in the North, 22*(1), 49-73.

Heikkinen, K.P., Seppänen, U.-M., & Isokangas, J. (2016). Entrepreneurship education in studio-based learning practices. In *Proceedings of The 11th European Conference on Innovation and Entrepreneurship*, 247.

Heikkinen, K.P., & Stevenson, B. (2016). The LAB studio model: enhancing entrepreneurship skills in higher education. *International Journal of Innovation and Learning, 20*(2), 154–168.

ILO, International Labour Office (2008). Skills for improved productivity, employment growth and development. In Report V, *International Labour Conference,* 97th Session.

Johnson, S., Blackman, D., & Buick, F. (2018). The 70:20:10 framework and the transfer of learning, *Human Resource Development Quarterly, 29*(4), 483–402.

Karjalainen, J., Seppänen, U.-M., & Heikkinen, K-P. (2016). Oamk LABs practices for bridging work-life 21st-century skills and higher education. *UAS Journal, Journal of Finnish Universities of Applied Sciences*, EAPRIL Special Issue.

Keller, J. M., & Keller, J. M. (2010). *Motivational design research and development*, 297-323. Springer US.

Kilpi, E. (2016). Perspectives on new work: Exploring emerging conceptualisations. *Sitra Studies*, p. 114.

Kluger, A., & DeNisi, A. (1996). The effects of feedback interventions on performance: a historical review, a meta-analysis, and a preliminary feedback intervention theory, *Psychological Bulletin, 119*(2), 254-284.

Kolb, D. (2014). *Experiential learning: Experience as the source of learning and development.* FT press.

Kuhn, S. (2001). Learning from the architecture studio: Implications for project-based pedagogy. *International Journal of Engineering Education*, *17*(4/5), 349–352.

Masood, R., & Pareto, L. (2021). Workplace work-integrated learning: supporting industry 4.0 transformation for small manufacturing plants by reskilling staff, *International Journal of Lifelong Education, 40*(1), 5-22.

Nonaka, I. (1994). A dynamic theory of organisational knowledge creation. *Organization Science, 5*(1), 14–37.

Nonaka, I., & Takeuchi, H. (1995). *The knowledge-creating company: How Japanese companies create the dynamics of innovation.* New York: Oxford University Press.

OECD, Organisation for Economic Co-operation and Development (2005). The definition and selection of key competencies: Executive summary. https://www.oecd.org/pisa/35070367.pdf.

Oguamanam, V., Lee, T., McKlin, T., Cochran, Z., Abowd, G., & DiSalvo, B. (2020). Cultural clash: Exploring how studio-based pedagogy impacts learning for students in hci classrooms. In *Proceedings of the 2020 ACM Designing Interactive Systems Conference,* 1131–1142.

Pereira, A. C., & Romero, F. (2017). A review of the meanings and the implications of the Industry 4.0 concept. *Procedia manufacturing, 13*, 1206-1214.

Reiter-Palmon, R., Wigert, B., & de Vreede, T. (2012). Team creativity and innovation: The effect of group composition, social processes, and cognition. In *Handbook of Organisational Creativity*, 295-326. Academic Press.

Rodriguez, C., Hudson, R., & Niblock, C. (2018). Collaborative learning in architectural education: Benefits of combining conventional studio, virtual design studio and live projects. *British Journal of Educational Technology, 49*(3), 337–353.

Rohrer, D., & Harold P. (2010). Recent Research on Human Learning Challenges Conventional Instructional Strategies. *Educational Researcher, 39*(5), 406–12.

Rojko, A. (2017). Industry 4.0 concept: Background and overview. *International journal of interactive mobile technologies, 11*(5).

Ryan, R., & Deci, E. (2017). *Self-determination theory: Basic psychological needs in motivation, development, and wellness*. Guilford Publishing, New York.

Saavedra, A., & Opfer, V. (2012). Learning 21st-century skills requires 21st-century teaching. *Phi Delta Kappan, 94*(2), 8-13.

Schnittka, C. G., Brandt, C. B., Jones, B. D., & Evans, M. A. (2012). Informal engineering education after school: Employing the studio model for motivation and identification in STEM domains. *Advances in Engineering Education*, *3*(2), n2.

Schön, D. (1987). *Educating the Reflective Practioner.* San Francisco: Jossey-Bass.

Seppänen, U.-M., Heikkinen, K.-P. & Stevenson, B. (2016). Oamk LABs. In D. Remenyi (ed.), *Innovation & Entrepreneurship Teaching Excellence Awards - An Anthology of Case Histories* (111–126). Reading: Academic Conferences and Publishing International.

Sitko-Lutek, A., & Jakubiak, M. (2020). Methods of employee development in the context of diversity, *International Journal of Innovation and Learning, 27*(2), 197-211.

Toffler, A. (2022). *Powershift: Knowledge, wealth, and Power at the Edge of the 21st Century.* Bantam.

Tynjala, P. (2008). Review: Perspectives into learning at the workplace, *Education Research Review, 3*(2), 130–154.

Violato C., Lockyer J., & Fidler H. (2008). Changes in performance: a 5-year longitudinal study of participants in a multi-source feedback programme, *Medical Education, 42*(10), 1007–1013.

Vollmeyer, R., & Rheinberg, F. (2005). A surprising effect of feedback on learning, *Learning and Instruction, 15*(6), 589- 602.

World Economic Forum (2020). *The future of jobs report 2020.* Retrieved from https://www.weforum.org/reports/the-future-of-jobs-report-2020/.

Yip, K. (2006). Self-reflection in reflective practice: A note of caution. *British Journal of Social Work, 36*(5), 777–788.